Short Range Wireless Technologies

Short Range Wireless Defined

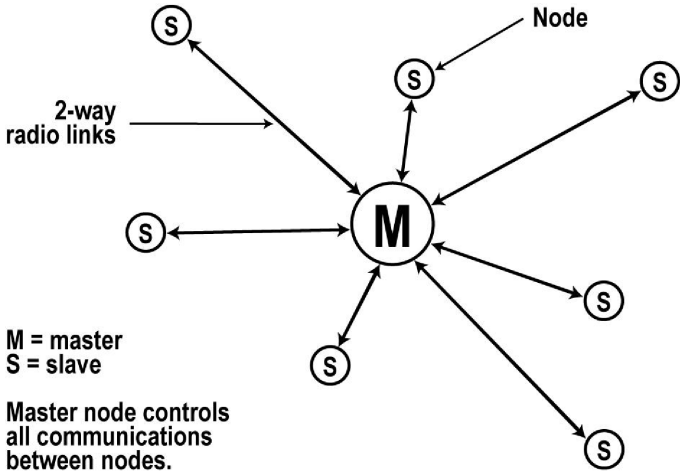
Short range wireless is just what the name implies: radio technologies designed for communicating over distances up to about 10 meters or just over 30 feet.

Many short range wireless technologies are designed for cable replacement. Instead of using a cable to control, communicate, or monitor some function electronically, a small inexpensive data radio is used.

Some common examples are garage door openers, TV remote controls (infrared, not radio), toys, and remote keyless entry devices on cars and trucks.

Numerous new applications have been discovered for short range wireless now that very tiny low cost integrated circuit radios are available.

Personal Area Networks (PANs)



A PAN is the interconnection of two or more devices, usually by radio, for the purpose of exchanging data. The range is less than 10 meters.

A PAN provides a way for devices to discover one another and link up automatically if they are within range of one another.

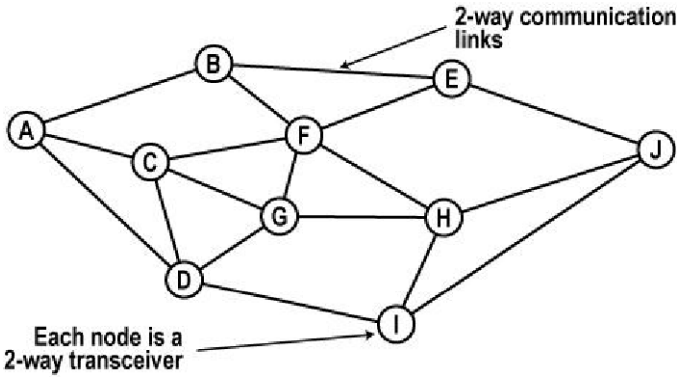
Most PANs consist of only two devices but some permit up to 8 devices to be connected to one another. Each communicating device is called a node.

PANs: Communication

Some PAN standards allow mesh networks to be formed where each radio may send or receive data but may also serve as a repeater to pass data from one nearby node to another thereby extending the range of each node.

Node A cannot communicate directly with node J because they are too far away from one another. However, they can communicate by different paths through nodes B and E, B-F-H, or D and I.

If one node fails, communications will be re-routed through other working nodes making the system highly reliable.



Major Categories of Short Range Radios

Other categories of short range radio include Bluetooth, ZigBee, Ultra wideband, and radio frequency identification.

Bluetooth is used primarily for communications from headset to cell phone, but also used in other PC, laptop, PDA, and computer peripheral communications.

ZigBee is used mainly in industrial monitoring and control. It automatically networks multiple items.

Ultra wideband (UWB) was designed for secure communications but this technology is emerging as a way to transmit very high frequency data like video over short distances at very high speeds.

Radio frequency identification (RFID) is just now becoming a key wireless technology that replaces or enhances the popular bar codes.

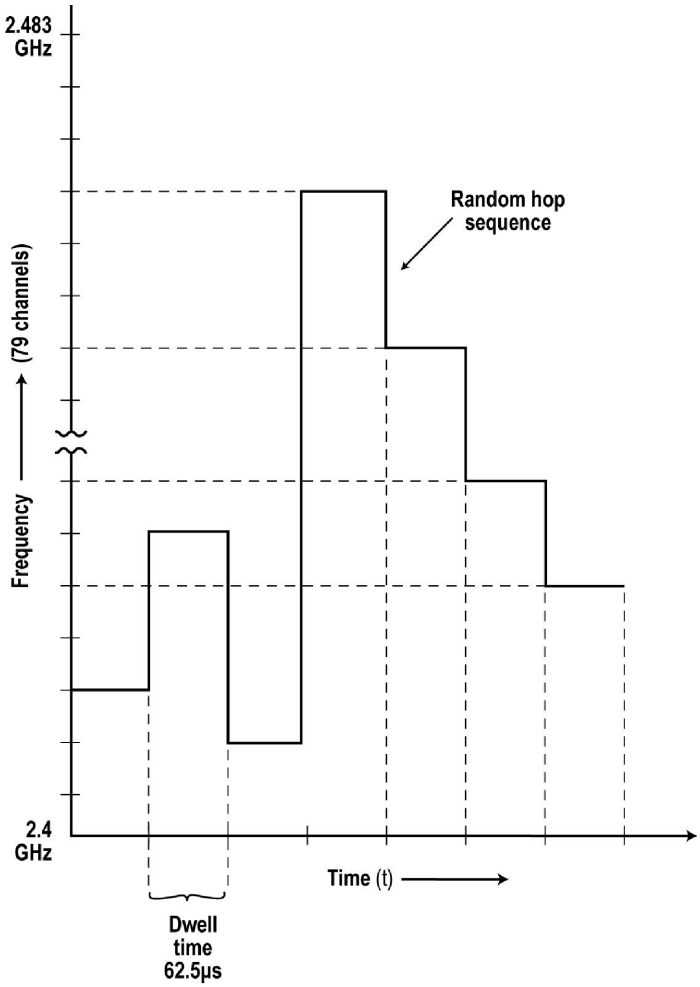
Bluetooth

Bluetooth operates in the 2.4 GHz unlicensed band, the same used for WLANs.

Bluetooth uses frequency hopping spread spectrum (FHSS) to permit many users to share the same band.

FHSS causes the frequency of transmission to be rapidly changed many times during the transmission of the binary data.

The frequency hop sequence is set by a pseudo random code that identifies a transmitter at the receiver.



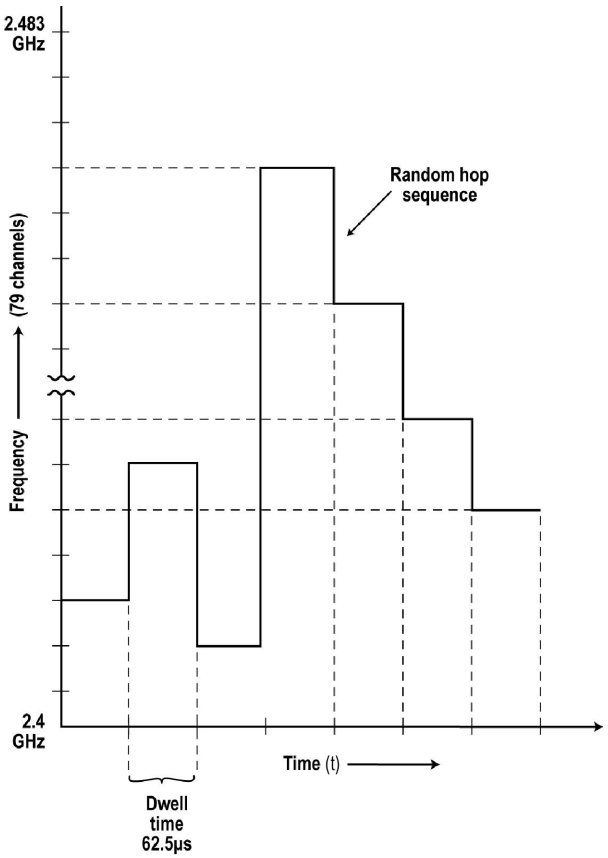
Bluetooth Described

A Bluetooth transceiver randomly hops to one of 79 frequencies at a rate of 1600 hops per second. This means that the transmitter remains or dwells on each frequency for 62.5 microseconds.

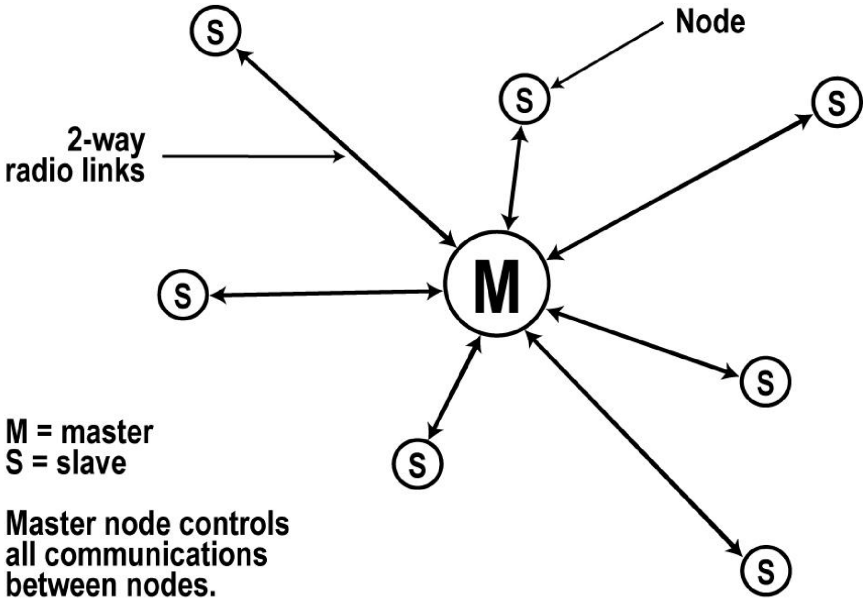
The modulation used is FSK.

The maximum data rate is 1 Mbps though a newer version called Enhanced Data Rate (EDR) can transmit at 3 Mbps.

The maximum range is about 30 feet.

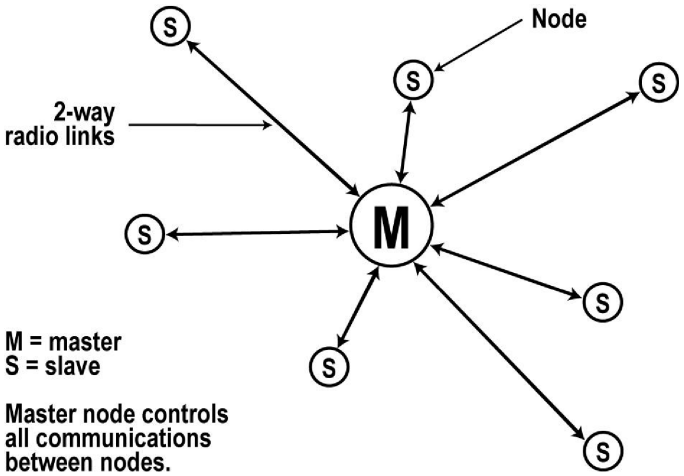


Piconets



Bluetooth-enabled devices automatically seek out and link up with other nearby Bluetooth devices to form piconets, small networks of up to 8 Bluetooth devices. One of the Bluetooth devices serves as the Master controller that talks to up to 7 slave radios.

Piconets



Single chip Bluetooth transceiver ICs are widely available from many sources making Bluetooth easy to implement.

Bluetooth was developed by the wireless company Ericsson and the standard was formalized in the Bluetooth Special Interest Group (SIG). It is also an IEEE standard 802.15.1.

ZigBee

ZigBee is another short range technology that uses the unlicensed 2.4 GHz band.

ZigBee operations can also take place in the 902-928 MHz range in the US (915 MHz is typical) or on 868 MHz in Europe.

Data rate is 250 kbps in the 2.4 GHz band and either 40 kpbs in the 915 MHz band and 20 kbps in the 868 MHz band.

ZigBee uses DSSS and FSK.

ZigBee

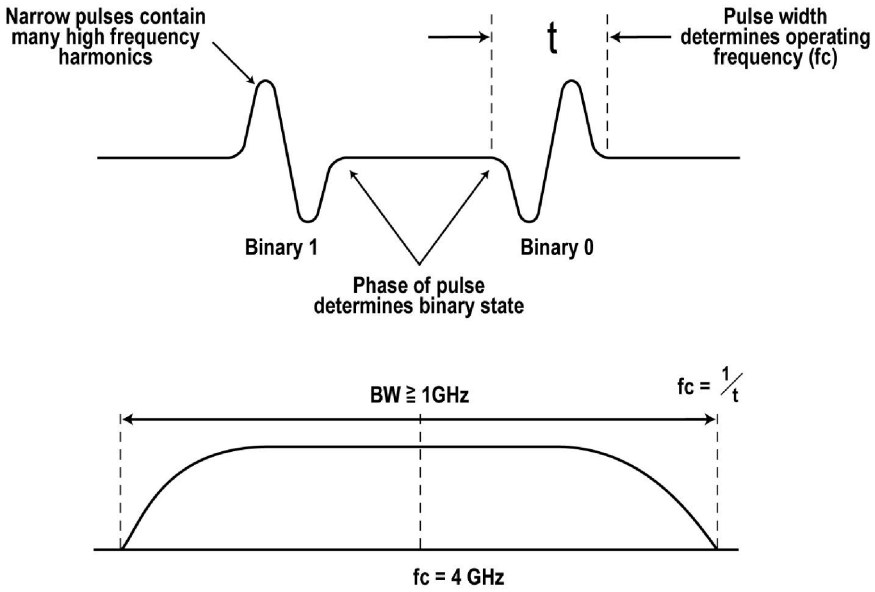
Applications include industrial telemetry and monitoring of building temperature, pressure, light level, and other physical conditions using sensors attached to ZigBee transceivers. Remote control operations are also possible.

ZigBee devices automatically network with one another to form mesh networks if they are within range. The range is up to 100 feet.

Single chip ZigBee transceiver ICs are available from several sources.

The ZigBee standard is maintained by the ZigBee Alliance and is an IEEE standard 802.15.4.

Ultra Wideband (UWB)



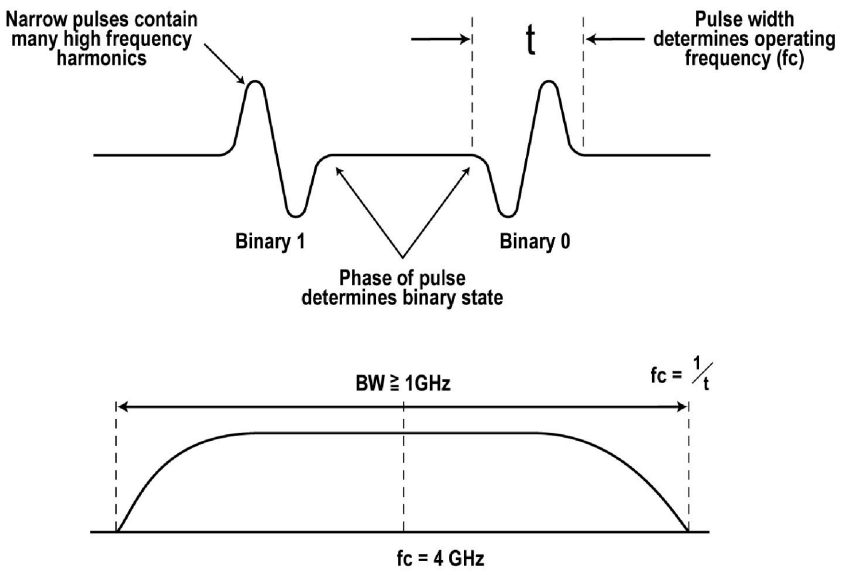
UWB is an unusual wireless technique that uses very short pulses to represent binary data. The short pulses contain many frequencies a Fourier theory indicates. The resulting signal occupies a very wide bandwidth.

If the pulse width (t) is 250 picoseconds, the center operating frequency f_c is the reciprocal of the pulse width or $1/250 \times 10^{-12} = 4$ GHz.

Ultra Wideband (UWB)

UWB can be used in the 3.1 to 10.6 GHz spectrum range. To be defined as UWB, the signal bandwidth must be at least 500 MHz wide or 25% of the center frequency, which ever is wider. In the figure shown here, the bandwidth (BW) must be 0.25 x 4 GHz or 1 GHz to be UWB.

Data rates can be very high such as 100 Mbps and up to 1 Gbps. This makes UWB useful for transmitting video.



Ultra Wideband Application

UWB is not widely used due to the lack of a formal widely accepted standard. The IEEE is developing a standard 802.15.3a, but there is conflict with existing proprietary versions that is being debated.

The target application is consumer electronics for connecting video devices (TV sets, cable boxes, DVD players, DVRs, and other devices) without wires.

Radio Frequency Identification (RFID)

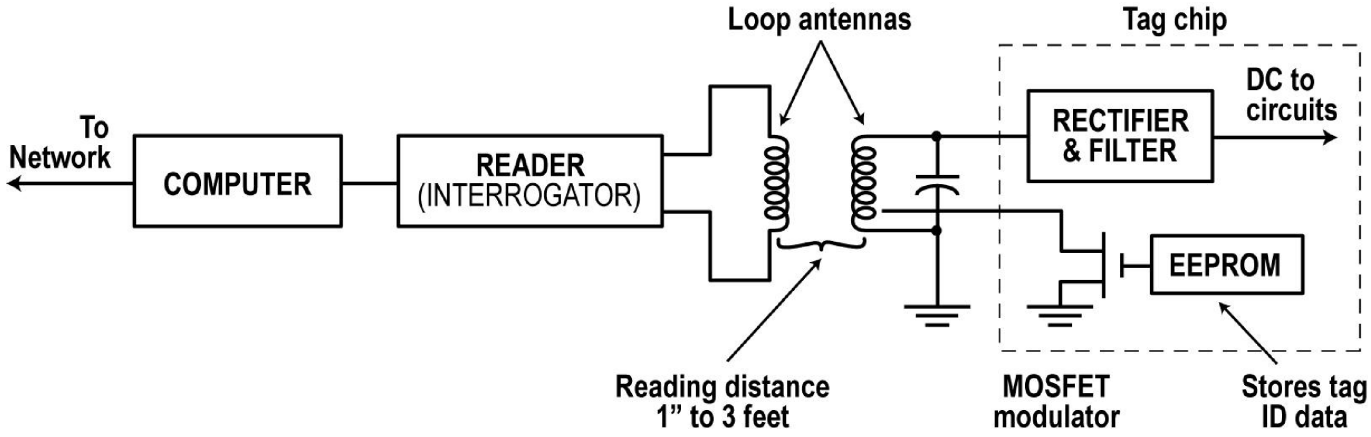
Radio frequency identification (RFID) is an electronic replacement for printed bar codes. It provides a way to electronically “tag” an item with a unique code and to interrogate the item by radio.

The tag is a single chip transmitter chip connected to a loop antenna that is applied to the item to be identified. When the radio signal from a nearby interrogator/reader passes near the tag, the tag powers up and transmits a unique code stored in its electrically erasable programmable read-only memory (EEPROM) to the reader.

Reading distances vary from a few inches to a several feet.

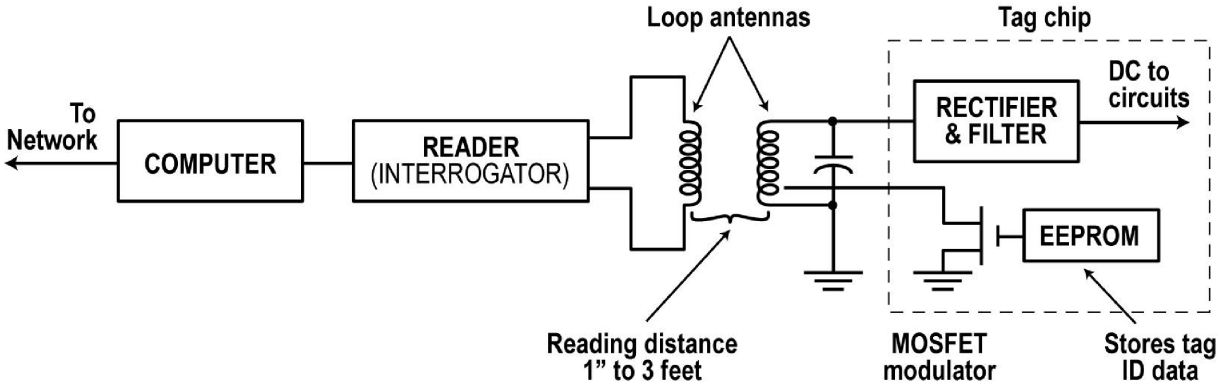
Frequencies of operation are 125 kHz, 13.56 MHz, 915 MHz, and 2.4 GHz.

RFID: Transmission



When the reader sends a signal to the tag, the magnetic field from its loop antenna cuts the turns of the tag antenna inducing a voltage. This voltage is rectified and filtered into a DC voltage that powers the tag circuits. The EEPROM then transmits its binary ID code by modulating the tag resonant antenna with a MOSFET producing a kind of amplitude modulation.

RFID: Reading



The reader reads the code and stores it in a computer for identification and further processing. Tags that operate this way are called passive tags since they do not need a battery or other power source.

RFID Applications

Applications include toll tags, inventory monitoring and control, shipping and receiving, baggage identification, animal tracking, consumer packaging identification, vehicle, and other capital equipment/major assets tracking.

RFID is currently used in the military and by some major retailers like Wal-Mart and is being adopted around the world.

RFID is expected to grow in use as tag prices drop to less than 25 cents. The new 800-900 MHz generation 2 tags are standardized world wide and are expected to speed adoption.

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